

CHAPTER 2

ELECTRICALLY OPERATED CANOPY SYSTEM

Chapter Objective: Upon completion of this chapter, you will have a working knowledge of the electrically operated canopy system and its components to include normal and emergency operation procedures.

As you know, the canopy system provides an access for the aviator to enter and exit the cockpit. It also provides protection from the elements. We will use the F/A-18C canopy system to discuss a typical electrically operated canopy system (fig. 2-1).

CANOPY SYSTEM

Learning Objective: Recognize the components of the canopy system.

Under normal conditions, the canopy is electrically operated and controlled by either the internal canopy control switch in the cockpit or the external canopy control switch, as shown in figures 2-2 and 2-3. A manual backup control mode operates the canopy when utility battery power is low, internal or external electrical power is not available, or the actuation control system has failed. The emergency canopy jettison system jettisons the canopy during emergencies and ejection.

SYSTEM COMPONENTS

You need to be familiar with the system components to enhance your understanding of the system's operation. Therefore, the following major components are described.

Canopy

The formed-stretched acrylic canopy is mounted in a metal frame. A canopy unlatch

thruster and two rocket motors and related ballistic components are mounted on the canopy for emergency jettison. An index pin, a control cam, and three latches are mounted on each side of the canopy frame.

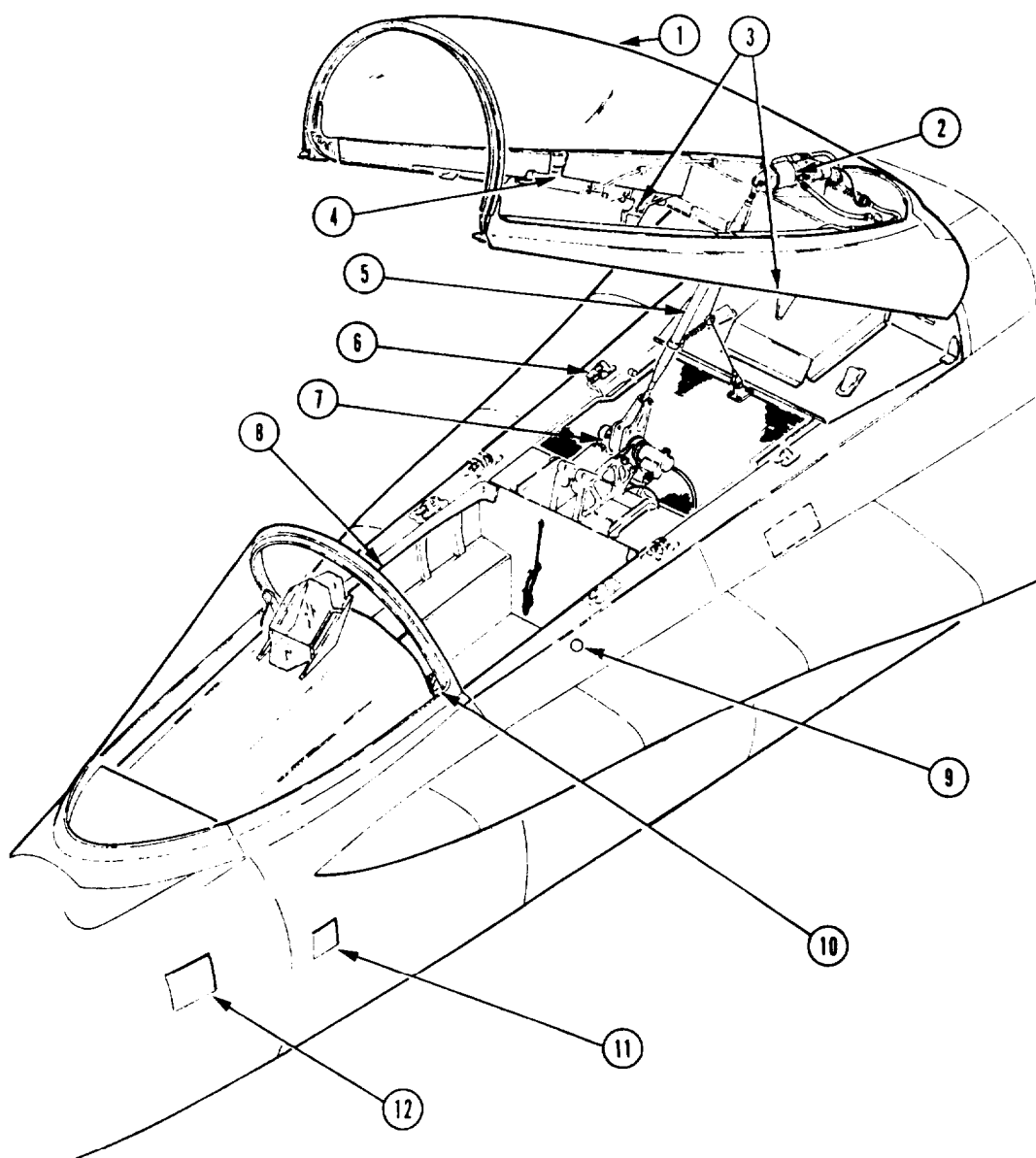
Canopy Pressure Seal

An inflatable canopy pressure seal is located around the canopy arch, along the side frames, and across the canopy deck. When the seal is inflated by the air-conditioning system, the canopy is sealed to the fuselage and windshield arch, allowing the cockpit to be pressurized. A noninflatable weather seal is located parallel to and outboard of the pressure seal. When the pressure seal is deflated, the weather seal prevents entry of water into the cockpit.

Canopy Actuator

The canopy actuator is located behind the aircraft ejection seat on the canopy deck and functions to open and close the canopy. A thermal protection device is provided in the actuator that will automatically interrupt power to the actuator when an overheat condition exists. It will automatically reset within 60 seconds after removal of the overheat condition.

The mechanical components of the canopy actuation system consist of the canopy actuator and the canopy actuation connecting link, which



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| 1. Canopy | 7. Canopy actuator |
| 2. Canopy unlatch thruster | 8. Internal canopy control switch |
| 3. Canopy control cams | 9. Canopy external manual jettison receptacle |
| 4. Canopy jettison rocket motor | 10. Internal canopy jettison handle |
| 5. Canopy actuation link | 11. External canopy control switch |
| 6. Canopy latch retainer | 12. External canopy jettison handle |

Figure 2-1.—Electrically operated canopy.

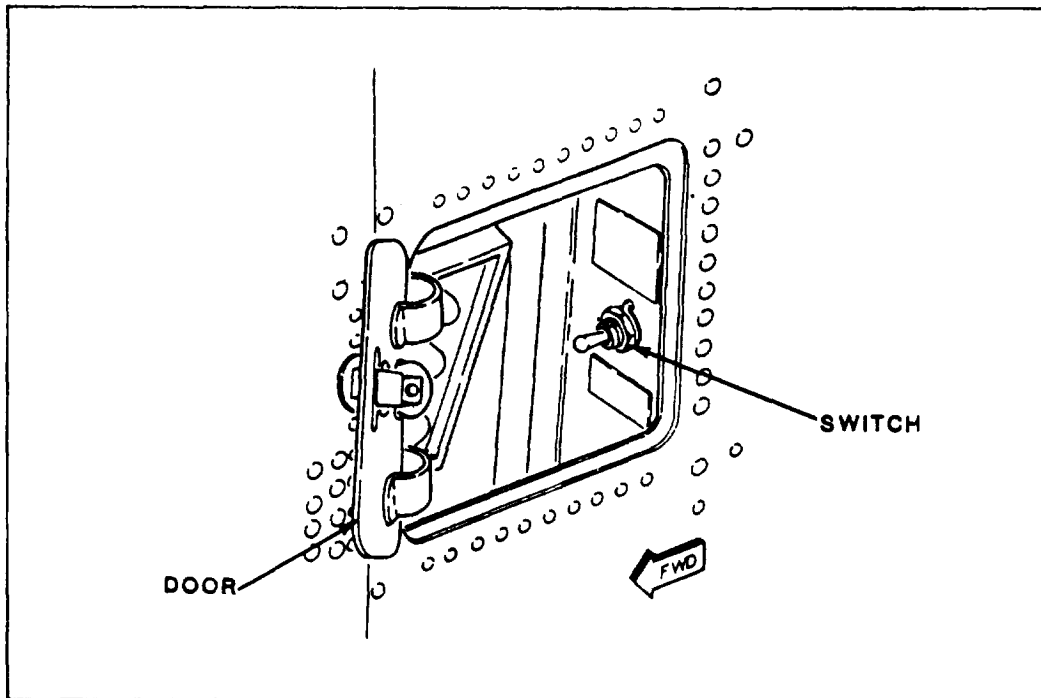


Figure 2-2.-External canopy control switch.

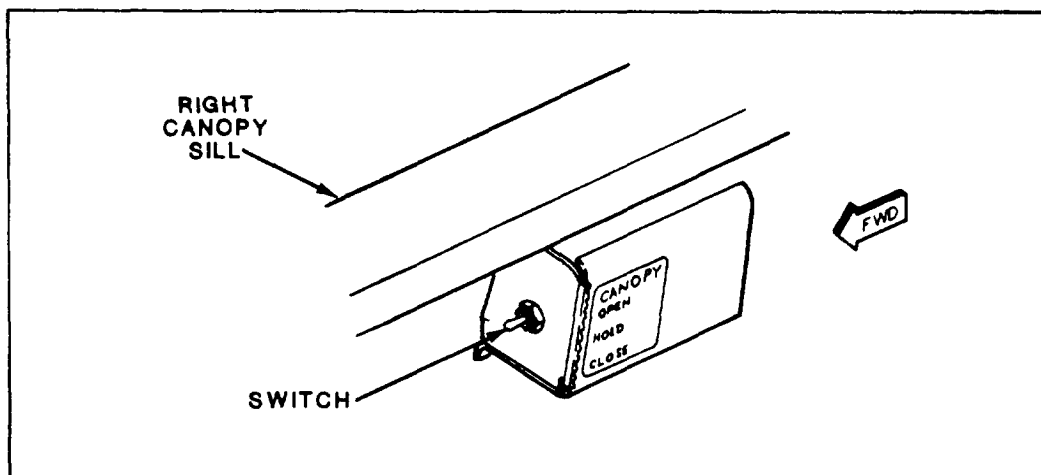


Figure 2-3.-Internal canopy control switch.

is attached to the canopy unlatch thruster, as shown in figures 2-4 and 2-5.

Canopy Actuator Manual Drive Unit

The canopy actuator manual drive unit is located in the cockpit under the left canopy

sill. It is used to manually raise and lower the canopy.

The internal manual canopy opening handle is located on the canopy actuator manual drive unit. The handle is used to operate the drive unit from inside the cockpit. The opening handle shaft assembly is located between the canopy actuator manual drive unit and the canopy actuator. The

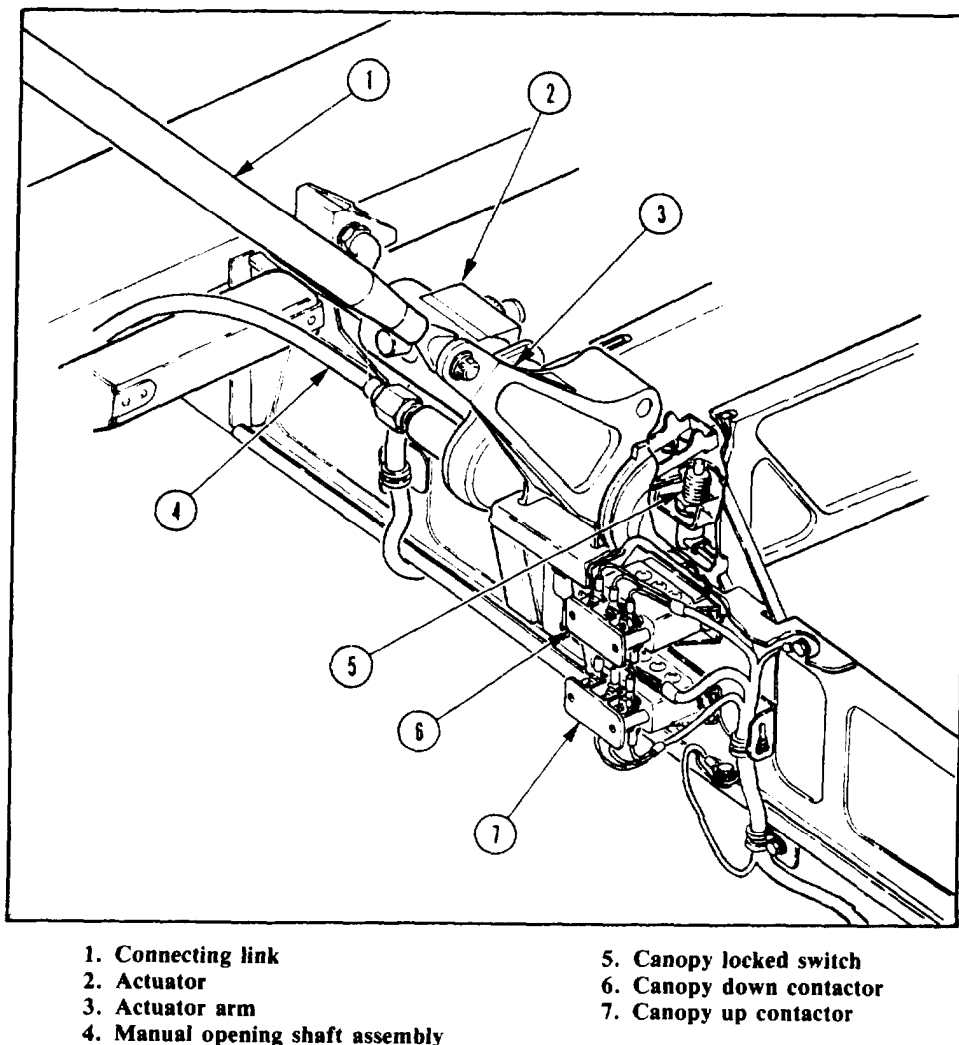


Figure 24.-Canopy actuator.

shaft assembly provides a mechanical link between the drive unit and the canopy actuator. (See fig. 2-6.)

The canopy external manual drive receptacle is mounted flush with the fuselage skin below the left canopy sill. The drive receptacle is used to operate the drive unit from outside the cockpit with the aid of a 3/8-inch drive tool. (See fig. 2-7.)

Canopy Control Switches

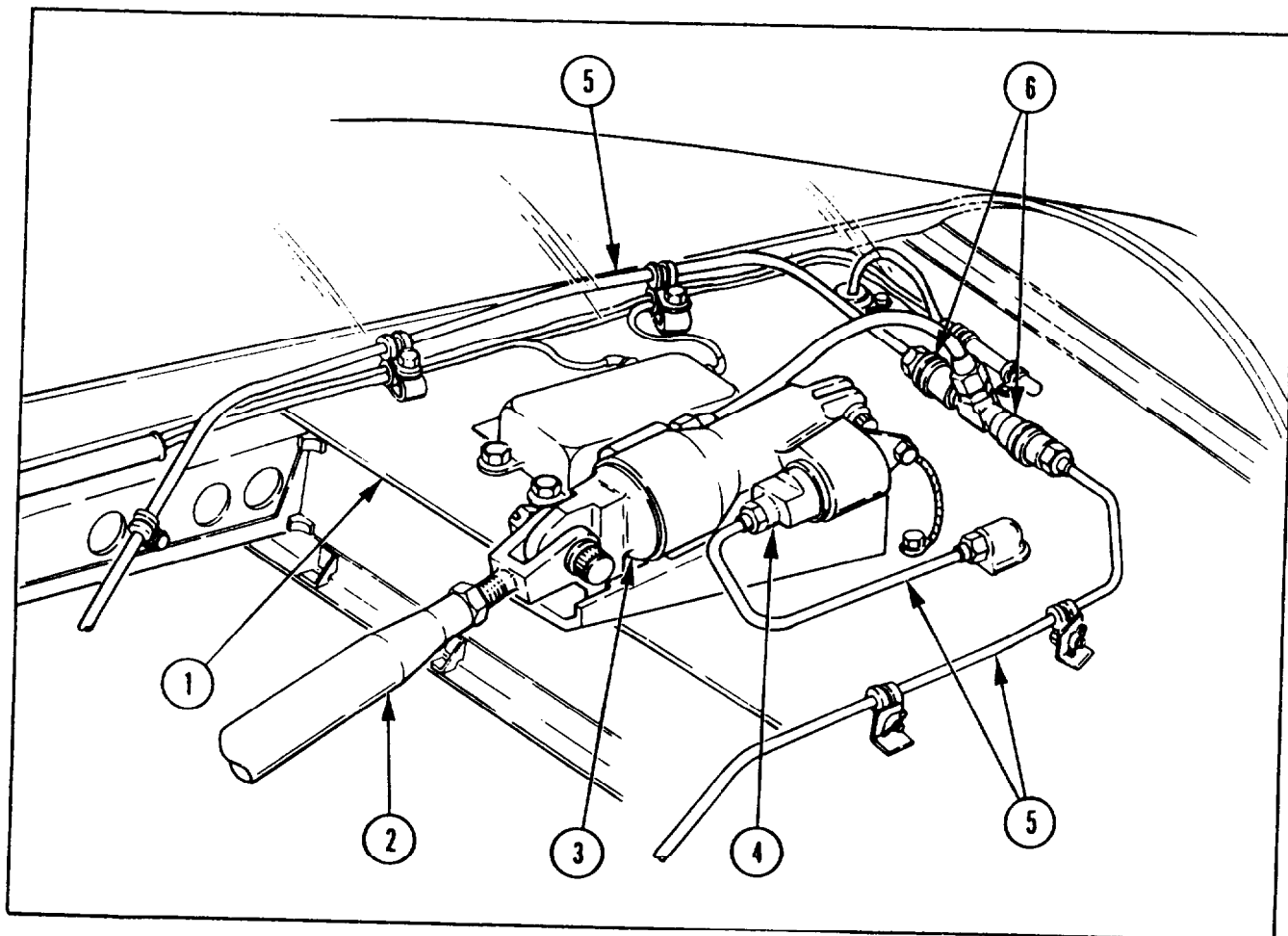
Two canopy control switches are provided for normal electrical operation of the canopy. The external canopy control switch is located inside the external electrical power receptacle door. (See fig. 2-2.) The internal canopy control switch is located in the cockpit under the right canopy sill. (See fig. 2-1.)

Canopy Contractors

The two contractors for canopy up and down are located on the forward bulkhead of the upper equipment bay. The down contactor supplies power to the close winding of the canopy actuator. The canopy up contactor supplies power to the open winding of the canopy actuator. (See fig. 2-4.)

Canopy Locked Switch

The canopy locked switch is located in the upper equipment bay under the canopy actuator. (See fig. 2-4.) When the switch plunger is depressed by the actuator arm, an electrical signal



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| 1. Canopy deck | 4. Canopy unlatch thruster cartridge |
| 2. Actuation connecting link | 5. SMDC |
| 3. Canopy unlatch thruster | 6. Canopy jettison rocket motor initiator |

Figure 2-5.-Canopy unlatch thruster.

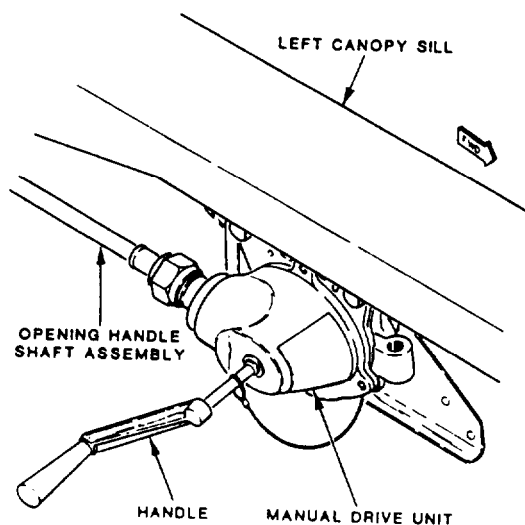


Figure 2-6.-Canopy actuator manual drive unit and handle.

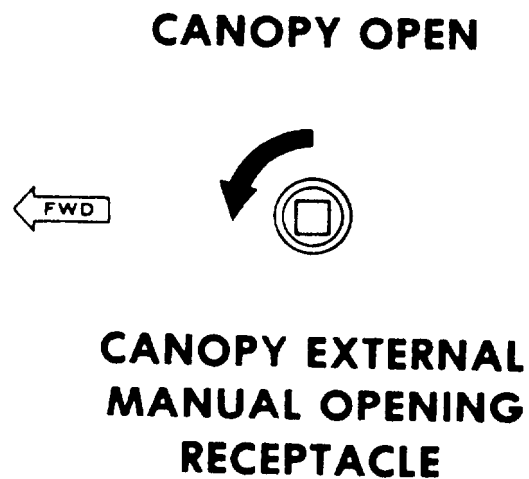


Figure 2-7.-Canopy external manual drive receptacle.

is supplied to extinguish the canopy warning light. The switch also interrupts power to the actuator.

Canopy Position Switch

The canopy position switch is mounted on the right canopy sill in the No. 4 canopy latch retainer. When the plunger switch is depressed by the No. 4 right canopy latch, an electrical signal is supplied to extinguish the canopy warning light. (See fig. 2-8.)

MISCELLANEOUS COMPONENTS

Other systems and components that are related to the canopy system are the canopy electrical system, air-cycle air-conditioning system, maintenance status display and recording system, mission computer system, and the multipurpose display group.

The F/A-18 aircraft electrical system supplies 28-volt dc power for canopy operation. Because the bus distribution system varies, depending upon the bureau number of the aircraft, refer to the maintenance instruction manuals to determine the applicable configuration. (See electrical system schematic shown in figure 2-9.)

The air-cycle air-conditioning system supplies partially cooled bleed air for the inflation of the canopy pressure seal to maintain cabin pressurization.

The maintenance status display and recording system, mission computer system, and multipurpose display group all receive inputs from the canopy system. Inputs are processed and supplied to the left digital display indicator and master caution light. The inputs are also processed, recorded, and displayed as maintenance codes on the nosewheel well digital display indicator. Canopy caution and warning indicators

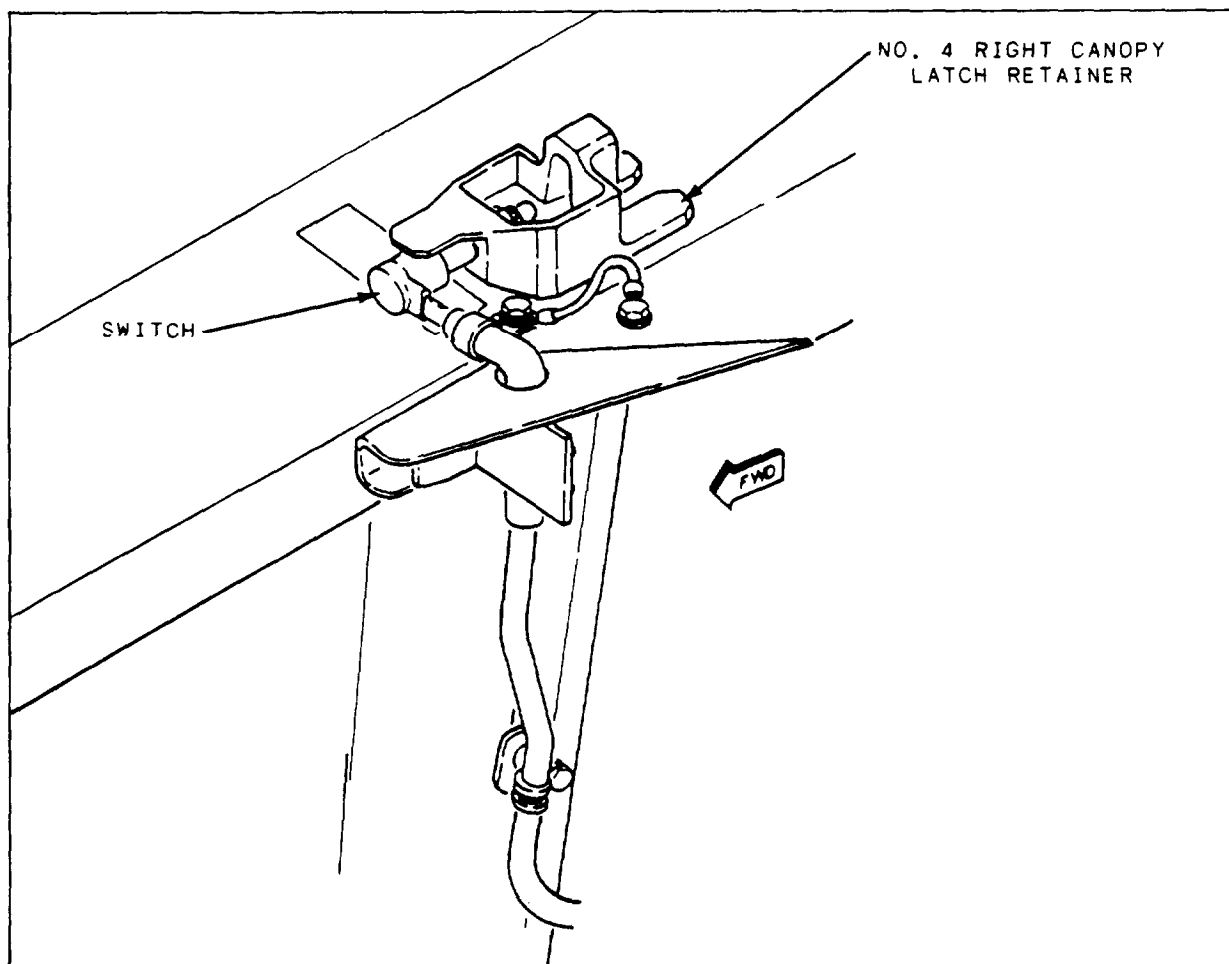


Figure 2-8.-Canopy position switch and latch retainer.

are made up of the following components: canopy caution light on the cockpit left digital display indicator, master caution light on the left-hand advisory and threat warning indicator panel, and the maintenance code display on the nosewheel well digital display indicator.

NORMAL OPERATION

Learning Objective: Identify the canopy normal mode of operation to include the manual backup mode.

The canopy is operated electrically by the external or internal canopy control switches in the normal control mode. The canopy can also be operated manually in the backup manual control mode if electrical power is not available.

NORMAL CONTROL MODE

The canopy may be operated with the external canopy control switch. To open the canopy, the switch is held in the OPEN position. The canopy stops automatically when the full open position is reached. To close the canopy, the switch is held in the CLOSE position until the canopy closes, moves full forward, and locks. The canopy stops automatically when the closed and locked position is reached. Motion may be stopped at any point during opening or closing by releasing the switch. The switch returns to the HOLD position when released.

To open the canopy internally with weight on the wheels, the internal canopy control switch is set to OPEN and released. The switch is magnetically held in the OPEN position until the canopy raises to full open and stops. The switch then returns to HOLD. Canopy motion may be stopped at any point during canopy opening by manually setting the switch to the HOLD position, which overrides the magnetic holding coil. The internal canopy control switch opening circuit is equipped with a weight-off-wheels relay that de-energizes the magnetic holding coil when the aircraft is in a weight-off-wheels condition. With the holding coil de-energized, the switch must be manually held to the OPEN position when opening the canopy.

When the canopy closes, moves full forward, and locks, the No. 4 right canopy latch depresses the canopy position switch plunger. Simultaneously, the canopy actuator arm rotates overcenter and depresses the canopy locked switch

plunger. Depressing both switch plungers causes the master caution light and the canopy display on the left digital display indicator to extinguish, indicating the canopy is fully closed and locked. If both switches are not fully depressed or a failure occurs in either switch, the master caution and canopy caution indicators will remain illuminated. If both switch plungers are not depressed within 15 seconds, the canopy switches disagree and the maintenance code (889) will be displayed on the nosewheel well digital display indicator.

Electrical inputs supplied to the canopy actuator are transformed into mechanical motion used to raise and lower the canopy. The actuator is equipped with an up-travel-limit switch, which automatically interrupts power to the actuator when the full open position is reached. With no aircraft generator power or external power applied, a utility battery supplies power for at least five open and close cycles of the canopy. On some F/A-18 aircraft, a logic circuit in the battery and charger unit secures the canopy control power when the battery voltage drops below 19 ± 1 volts.

Due to decreased battery capacity at low temperatures, canopy operation using battery power is not recommended when ambient temperature is below 0°F. Under these conditions, external electrical power should be used. When external power is not available, the canopy can be operated using the backup manual control mode.

To further understand how the opening and closing cycles function, refer to figure 2-9.

BACKUP MANUAL CONTROL MODE

The backup manual control mode is used to open and close the canopy when utility battery power is low, internal or external electrical power is not available, or a failure has occurred in the canopy actuation control system.

The canopy actuator manual drive unit is operated from inside the cockpit by using the internal manual canopy opening handle. The handle is removed from its stowage receptacle and clip, and then it is inserted into the crank socket. The handle is turned 70 ± 1 turns clockwise to close the canopy or counterclockwise to open the canopy. The internal manual canopy opening handle shaft assembly mechanically links the drive unit to the canopy actuator. By operating the drive unit internally or externally, mechanical motion is transferred through the shaft assembly to the canopy actuator.

- LEGEND**
- ① 161353 THRU 161528.
 - ② 161702 AND UP.
 - ③ DC POWER SYSTEM SIMPLIFIED SCHEMATIC.
 - ④ 24/28 VDC MAINT BUS IS POWERED BY UTILITY BATTERY AND CHARGER UNIT IF L28 VDC BUS IS NOT POWERED.

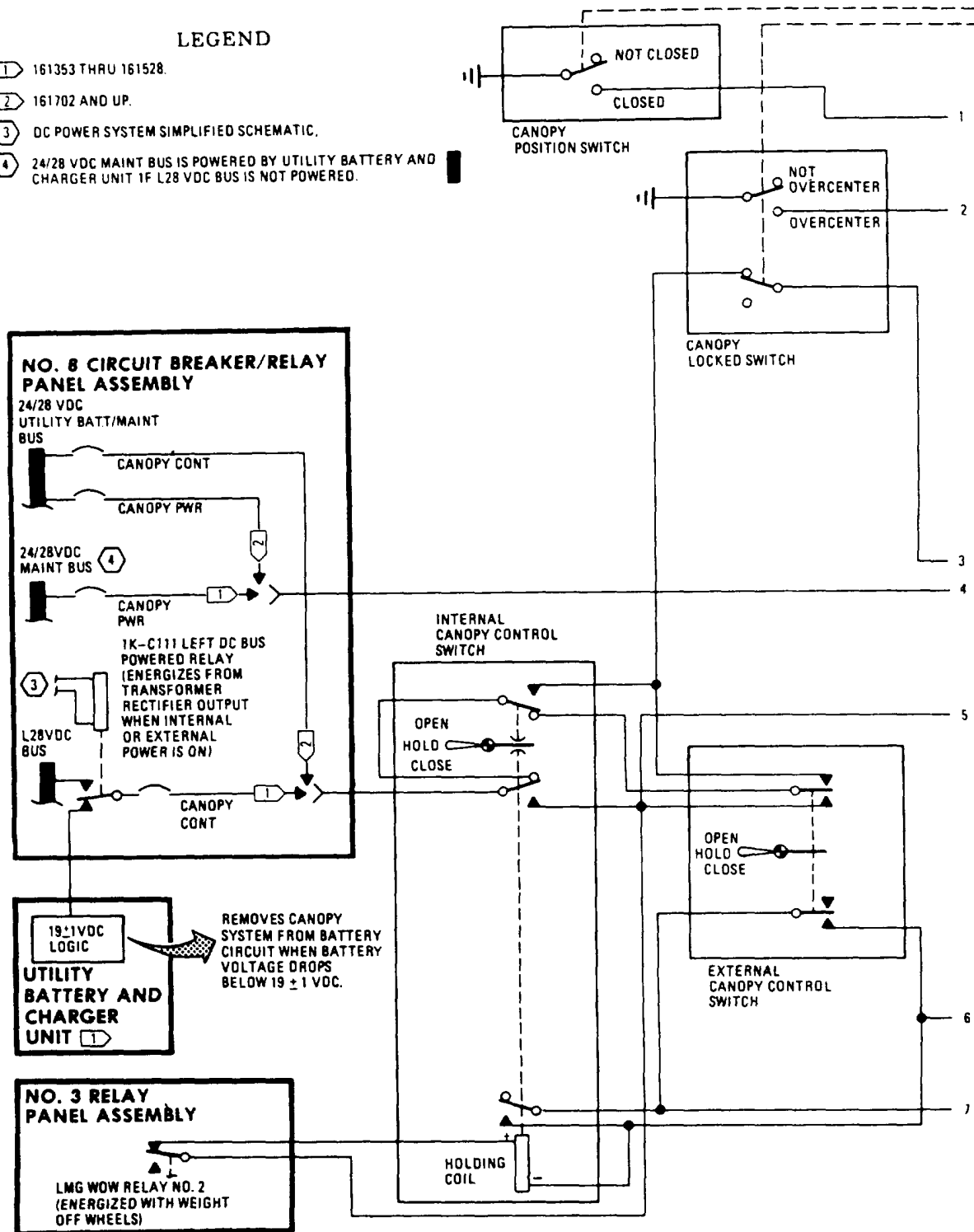


Figure 2-9.-Canopy electrical system schematic.

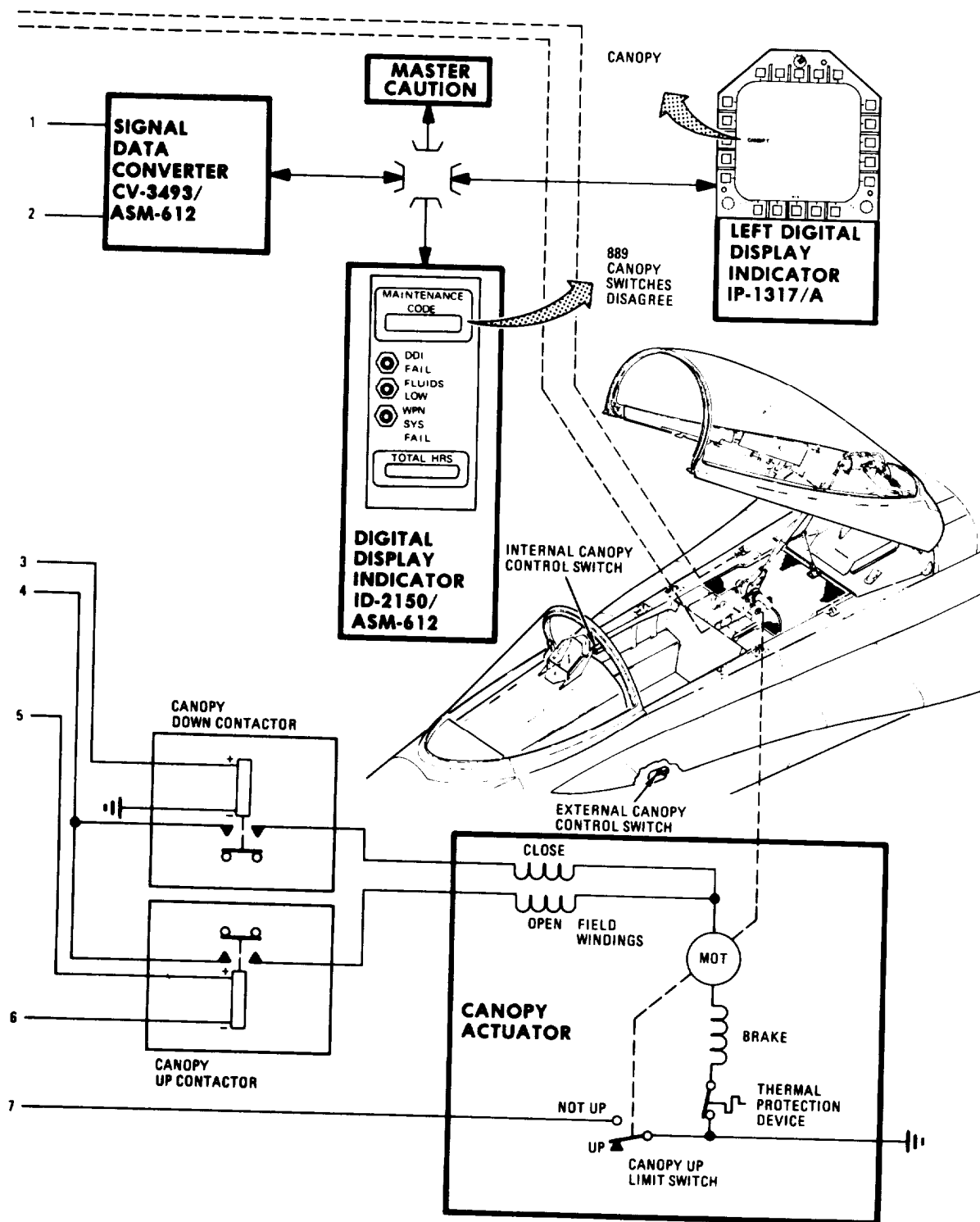


Figure 2-9.-Canopy electrical system schematic—Continued.

As previously stated, the canopy external manual drive receptacle is provided to operate the canopy actuator manual drive unit from outside the cockpit. A 3/8-inch drive tool is inserted into the drive receptacle and turned 35 ± 1 turns counterclockwise to open the canopy or clockwise to close the canopy.

Manually operating the canopy overrides the mechanical brake in the canopy actuator. The brake engages to hold the canopy at any position when manual cranking is stopped. The actuator is equipped with a mechanical torque limiter that prevents damage to the actuator if excessive torque is applied to the manual backup control mode.

EMERGENCY CANOPY JETTISON SYSTEM

Learning Objective: Recognize the system components and procedures for emergency canopy jettison.

The emergency canopy jettison system provides the capability to ballistically jettison the canopy in case of an emergency. The canopy can be jettisoned internally or externally without initiating seat ejection. It can also be jettisoned by initiating ejection. This is accomplished by pulling the ejection control handle on the ejection seat.

COMPONENTS

Before discussing the internal and external methods of jettisoning the canopy, a description of the system's components is needed.

External Canopy Jettison Handles And Cables

The external canopy jettison handles and cables are stowed behind doors on each side of the aircraft near the radome. (See figs. 2-1 and 2-10.) Each handle is attached to approximately 8 feet of cable. The cables are routed through the gun bay and are joined to a common cable at the cockpit forward pressure bulkhead. This single, common cable runs through the bulkhead into the cockpit, where it connects to the internal canopy jettison lever linkage.

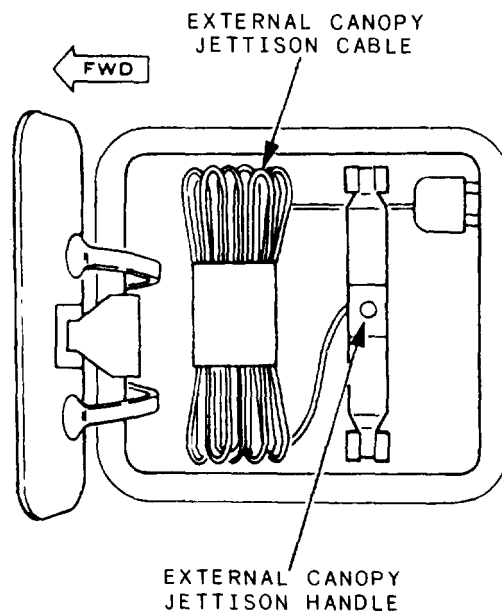


Figure 2-10.-External canopy jettison handle.

Internal Canopy Jettison Lever

The internal canopy jettison lever is located to the left of the main instrument panel. The lever is mounted on the canopy sill. (See fig. 2-11.) The lever gives the pilot the capability of starting the emergency canopy jettison sequence from inside the cockpit.

Canopy Jettison SMDC Initiator

The canopy jettison shielded mild detonating cord (SMDC) initiator is located below the canopy jettison lever. The initiator receives inputs from either the internal canopy jettison lever or external canopy jettison handles to initiate the jettison sequence.

One-way Transfer Valve

The one-way transfer valve is located on the ballistic panel in the upper equipment bay. The transfer valve acts as a check valve to prevent the backflow of SMDC detonation to the seat components.

Emergency Escape Disconnect

The emergency escape disconnect is located under the canopy deck. The disconnect provides a path for SMDC detonation to the canopy

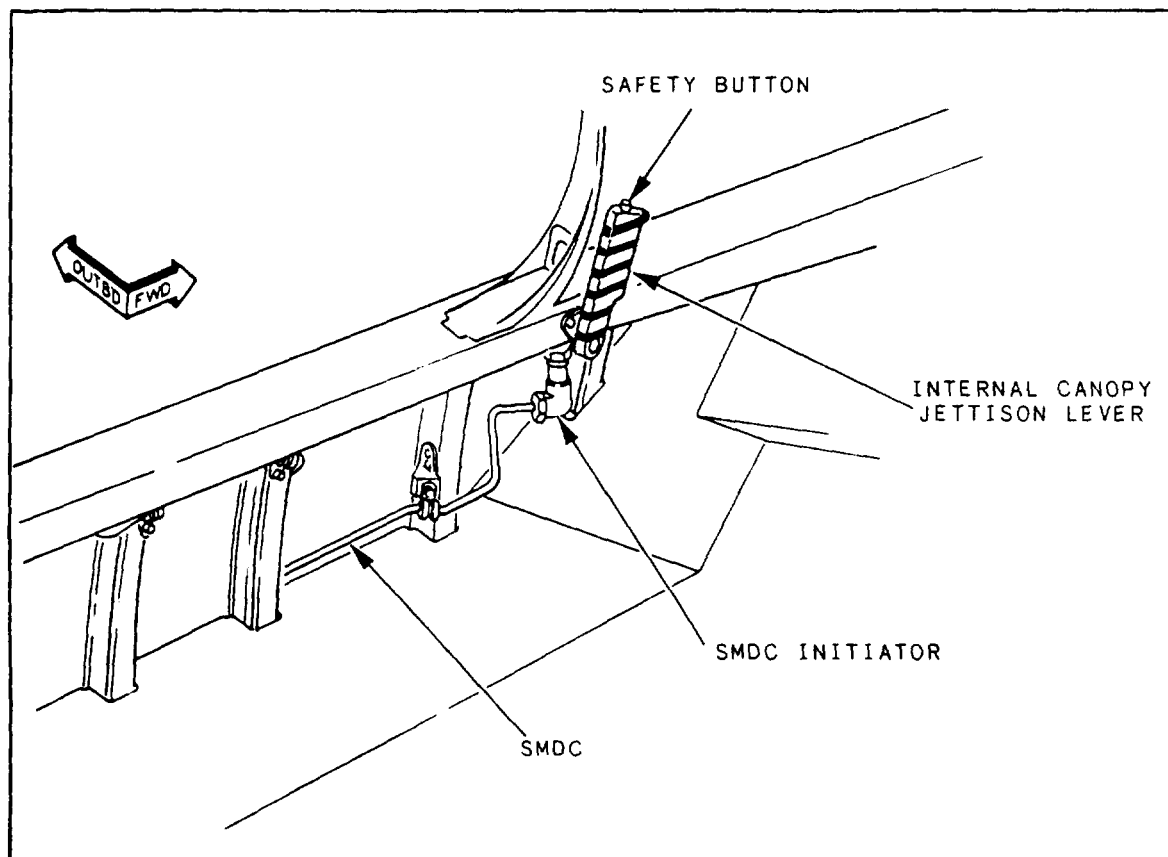


Figure 2-11.-Internal canopy jettison handle.

ballistic components and provides a disconnect point when the canopy is jettisoned or removed for maintenance.

Canopy Unlatch Thruster and Cartridge

The cartridge is mounted in the canopy unlatch thruster, as shown in figure 2-5. Pressure from the canopy jettison SMDC initiator fires the thruster mounted on the canopy deck. When fired, it moves the canopy aft to disengage the latches and separate the canopy from the actuation connecting link. Thruster ballistic gas is provided to the canopy jettison rocket motor initiators.

Canopy Jettison Rocket Motor Initiators

The rocket motor initiators are mounted on the canopy deck aft of the thruster as shown in figure 2-5. The initiators receive ballistic gas input

from the thruster to produce SMDC detonation to fire the rocket motors.

Canopy Jettison Rocket Motor

The rocket motors are located on either side of the canopy frame. The rocket motors are fired by the rocket motor initiators and provide the vertical thrust required to separate the canopy from the aircraft.

SMDC/FCDC Initiators

The SMDC and flexible confined detonating cord (FCDC) are located between the various ballistic components. The SMDC and FCDC provide the energy transfer stimulus used in the emergency canopy jettison system. The SMDC is sealed in stainless steel tubing to protect the cord and to contain all gases produced by explosive detonation. The FCDC is sealed in a metallic sheath, which is protected by a braid over-wrap.

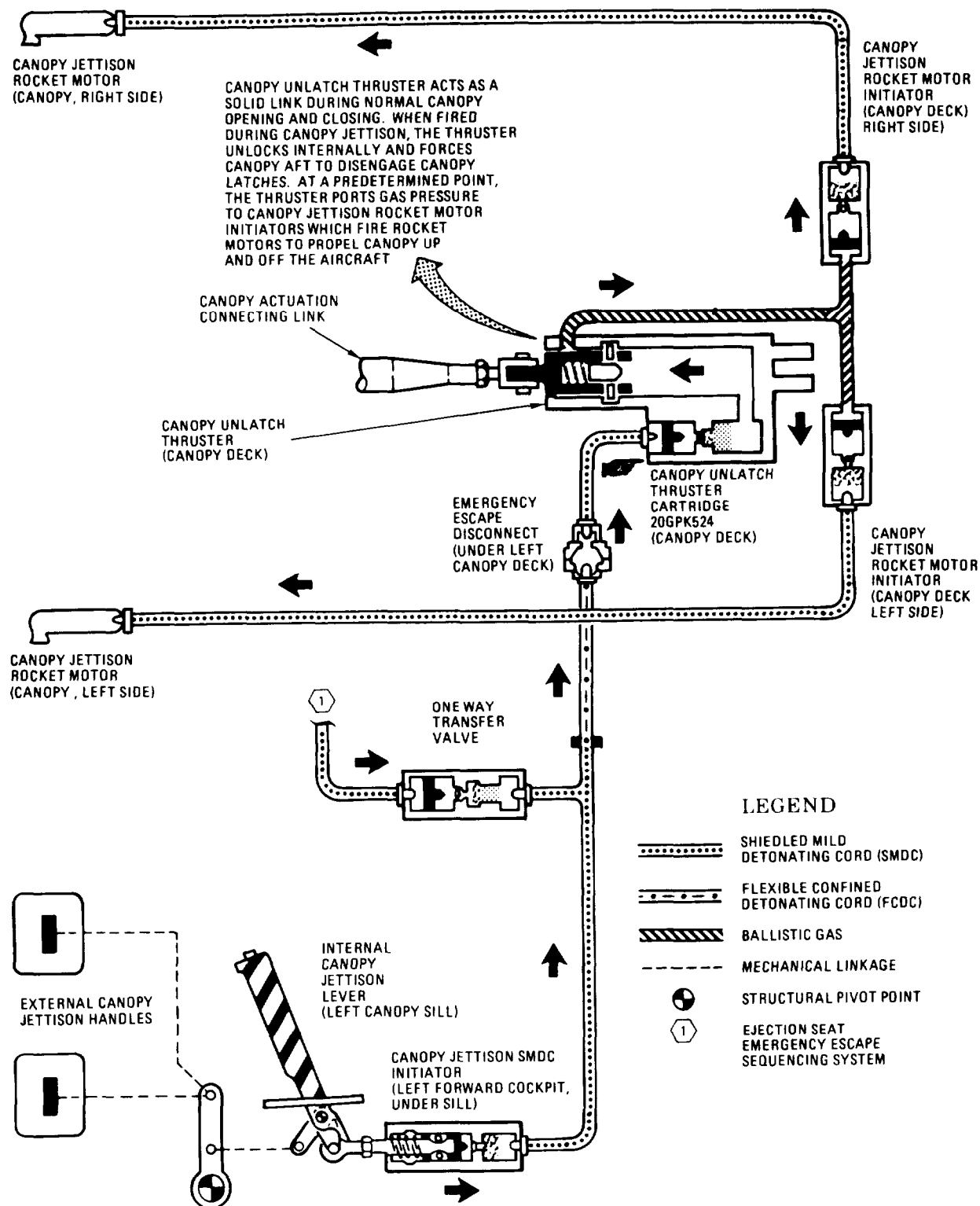


Figure 2-12.-Canopy jettison system schematic.

PROCEDURES

The canopy can be jettisoned by internal or external means. The following discussion summarizes both jettison procedures.

Internal Canopy Jettison

Internal canopy jettison is initiated by the internal canopy jettison lever. (See fig. 2-11.) By removing the canopy jettison safety pin and pressing down the safety button and pulling the lever aft, the canopy jettison SMDC initiator is fired. Explosive stimulus produced by the initiator is transferred through the SMDC to the emergency escape disconnect. The one-way transfer valve prevents the explosive stimulus from continuing toward the ejection seat components. The explosive stimulus continues through the emergency escape disconnect, via the FCDC, to the canopy unlatch thruster cartridge, which fires the canopy unlatch thruster. Firing the unlatch thruster pushes the canopy aft to disengage the canopy latches and separates the thruster from the connecting link. Ballistic gas produced by firing the thruster is transferred to the canopy jettison rocket motor initiators. The rocket motor initiators convert ballistic-gas pressure to explosive stimulus, which is transferred through SMDC to

fire the canopy jettison rocket motors. The rocket motors produce the vertical thrust required to separate the canopy from the aircraft. (See fig. 2-12.)

External Canopy Jettison

Ground emergency external canopy jettison is started by opening the door on either the left or right side of the aircraft and removing the canopy jettison handle from its retaining clip. The handle is attached to approximately 8 feet of cable. When the cable is fully extended and pulled, the canopy jettison SMDC initiator is fired, which, in turn, initiates the emergency canopy jettison sequence. From this point on, the sequence is the same as internal canopy jettison. The cable action merely bypasses the internal canopy jettison lever. When the canopy is jettisoned, all canopy jettison ballistic devices are spent.

WARNING

Ensure that the proper canopy jettison safety pin is installed whenever the aircraft is not flying or during any maintenance task performed on the aircraft.

